Name _____ Alpha _____

Instructor _____ Section # _____

# FINAL EXAM

# VERSION A

# SP211

# 14 DECEMBER 1998

# 0755 TO 1055

DIRECTIONS: The exam consists of 40 multiple choice items. Circle the letter corresponding to that response which best completes each statement. If you get bogged down on an item move on to the next one. After you have finished item 40 then go back to those you were unable to complete on first pass. When you have finished working on the exam then transfer you answers to the bubble sheet using a number 2 pencil. Do this carefully so you can avoid erasures on the bubble sheet as much as possible. To maintain a level playing field from section to section your instructor cannot assist you in interpreting any of the items.

**URGENT! IMPORTANT! URGENT! IMPORTANT!**

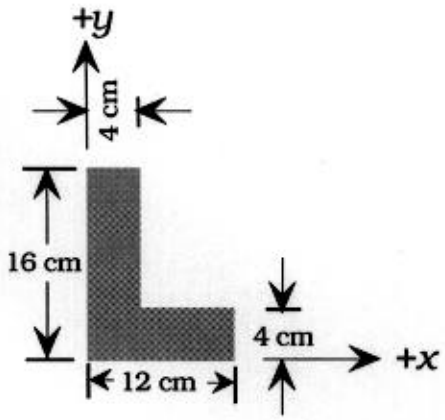
Be sure to enter the **version number** of this exam on the bubble sheet by filling in the **response A** bubble for **item 41**.

Do not turn page until told to do so.

1. Let W be the amount of work it takes to stretch a Hooke's law spring a distance *d* from its unstretched length. The *additional* work required to stretch it an *additional* distance *d* is:

A. W
B. 2W
✓C. 3W
D. 4W
E. 5W

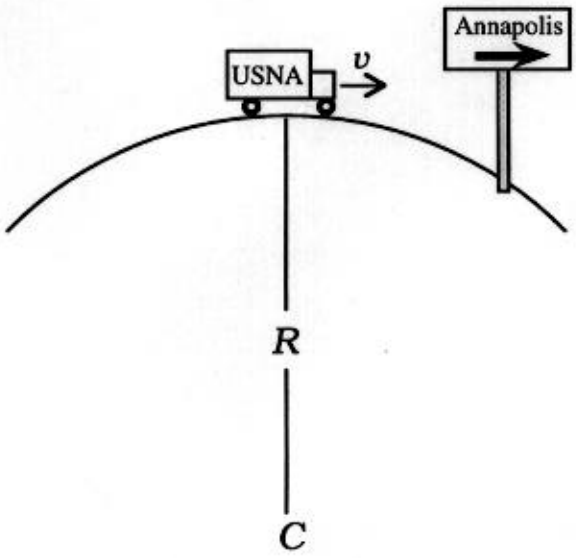
2. A uniform carpenters square has the shape of an L as shown. The center of mass has an x coordinate of




A. 2 cm
B. 3 cm
✓C. 4 cm
D. 5 cm
E. 6 cm

3. A **1000 kg** car, moving at a constant speed of **25 m/s**, rounds the crest of a hill with a radius of curvature R = **100 m.**

The *normal force* of the road *on* the car is:

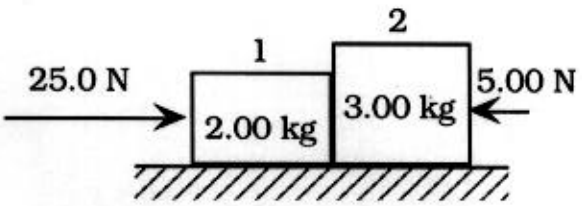



A. 2000 N
✓B. 3550 N
C. 6250 N
D. 9800 N
E. 16050 N

4. A 0.20-kg golf ball moving horizontally at 40 m/s strikes a vertical concrete wall at normal incidence and bounces straight back. The speed of the ball just after contact with the wall is 30 m/s. The duration of the collision is 5.0 ms. During the collision the average force exerted on the ball by the wall during is:

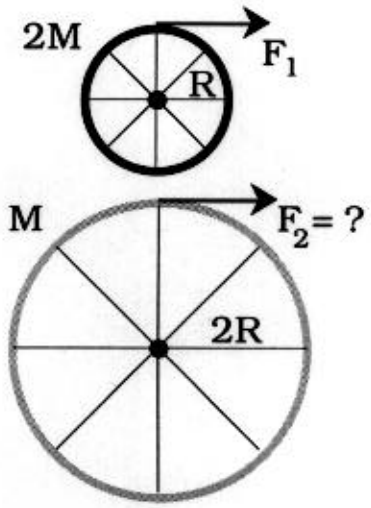
A. 400 N
B. 1200 N
C. 2200 N
✓D. 2800 N
E. 3200 N

5. Two blocks are on a frictionless horizontal surface as shown. Homer pushes block 1 to the right with a 25.0-N force while Bart pushes block 2 to the left with a 5.00-N force. The magnitude of the force exerted by block 1 on block 2?




A. 13.0 N
B. 15.0 N
✓C. 17.0 N
D. 22.0 N
E. 30.0 N

6. Two wheels rotate about fixed axes through their hubs. The mass of each wheel is concentrated at its rim (the spokes and hubs are massless). The smaller wheel has radius **R** and mass **2M** whereas the larger wheel has radius **2R** and mass **M** as shown.




To impart identical angular accelerations $F_2$ is

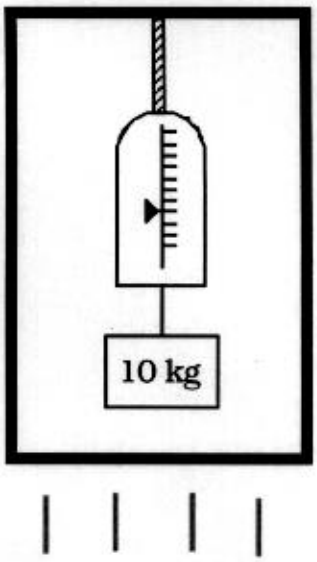
A. $\frac{1}{4}F_1$ B. $\frac{1}{2}F_1$ C. $F_1$ D. $\frac{3}{2}F_1$ E. $2F_1$

7. If a planet's mean distance from the Sun were *ten times* that of the Earth's, it would have an orbital period, in years, of:

A. 4.6
B. 10
C. 21
✓D. 32
E. 100

8. A **10-kg** mass is suspended from a spring scale and the scale is suspended from the ceiling of an elevator. The elevator is moving upward but is *slowing down* at a rate of **2.2 m/s²**.

The scale reads:




A. 0 ✓B. 76 N C. 98 N D. 118 N E. 150 N

This statement refers to the two following problems. A projectile is fired with unknown initial velocity, but is observed to have a *horizontal range* of **240 m** and a *time of flight* of **8.0 s.** The projectile lands at the same height that it was launched. Assume air resistance is negligible.

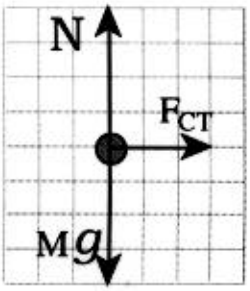
9. The *horizontal* component of the *initial* velocity is:

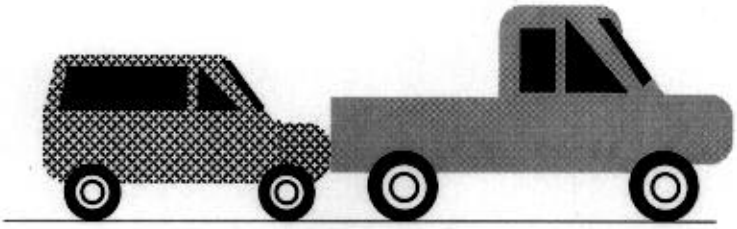
A. 16 m/s
✓B. 30 m/s
C. 48 m/s
D. 60 m/s
E. 72 m/s

10. The *vertical* component of the *initial* velocity is:

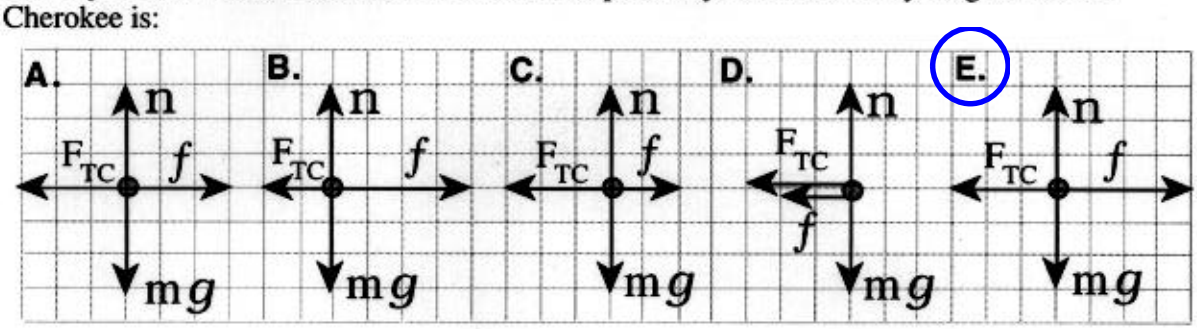
A. 24 m/s
B. 31 m/s
✓C. 39 m/s
D. 45 m/s
E. 98 m/s

11. Your friends rented truck has broken down on the highway. Because you are the good Samaritan type you agree to use your your Jeep Cherokee to push the truck to the nearest repair shop. Consider the free-body diagram of each vehicle as both vehicles are *coming up to speed.* The free body-diagram for the truck is shown to the right.



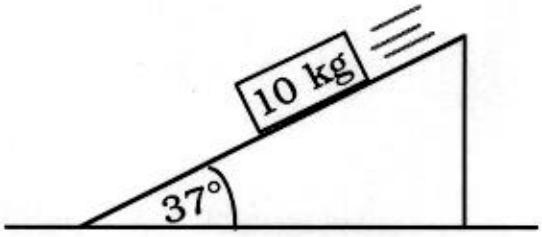



The force vectors are drawn to scale. Also, $F_{CT}$ is the force by the Cherokee on the Truck whereas $F_{TC}$ is the force by the Truck on the Cherokee. On the free-body diagrams below n and $f$ are the normal and frictional forces, respectively. The free-body diagram for the Cherokee is:




12. A **10 kg** block, released from rest on a **37°** inclined plane, slides down the plane—gaining speed at a rate of of **2.0 m/s$^2$**.

The frictional force on the block is:




A. 25 N
B. 34 N
✓C. 39 N
D. 55 N
E. 84 N

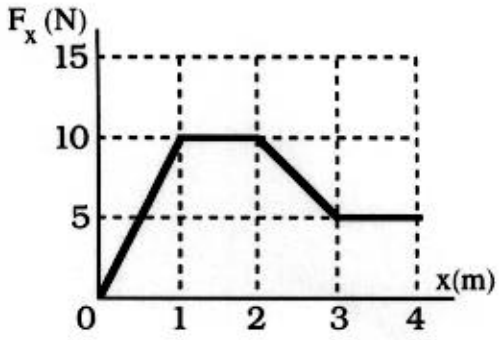
13. The bob of a pendulum has a mass of **2 kg** and is attached to the end of a **5.0-m**-long string. It starts *from rest* with the string taut, making an angle of **30°** from the vertical. As the bob passes through the lowest point of its path its *speed* is:

✓A. 3.6 m/s
B. 4.2 m/s
C. 5.1 m/s
D. 6.3 m/s
E. 7.8 m/s

14. A particle moves along the x-axis according to the equation $x = 5 - 3t + 2t^3$ where $x$ is in meters if $t$ is in seconds. The *average velocity* of the particle during the interval $1\ s < t < 3\ s$ is:

A. 14 m/s
B. 16.5 m/s
C. 18 m/s
✓D. 23 m/s
E. 27 m/s

15. A force $F_x$ acting on a particle varies with $x$ as shown in the plot to the right.




As the body moves from $x = 0$ to $x = 4$ m, the *work* done on the particle *by* the force is:

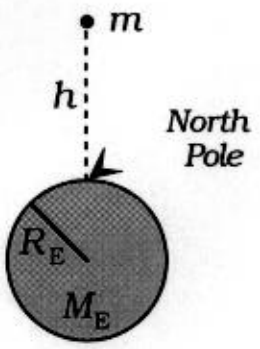
A. 17.5 J
B. 25.0 J
✓C. 27.5 J
D. 40.0 J
E. 47.5 J

16. The escape velocity at the earth's surface is given by

$$v_e = \sqrt{\frac{2GM_E}{R_E}}$$

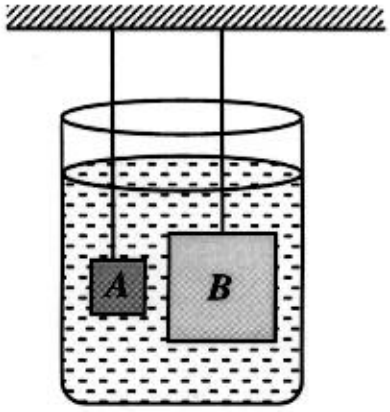
where $R_E$ and $M_E$ are the earths radius and mass, respectively.

At the north pole an object of small mass $m$ is given an upward initial velocity equal to half the escape velocity. How high $h$ above the Earth's surface is this object when it reaches its maximum height h. Neglect air resistance.




A. $\frac{1}{2}R_E$ B. $\frac{1}{\sqrt{2}}R_E$ ✓C. $\frac{1}{3}R_E$ D. $2R_E$ E. $2\sqrt{2}R_E$

17. Two cubes, $A$ and $B$, are completely submerged in water. $B$ has an edge length two times longer than does $A$, but a *mass* only half that of $A$.




The ratio of the *buoyant* force exerted on $B$ to that exerted on $A$ is:

A. 0.125
B. 0.25
C. 0.50
D. 4.00
✓E. 8.00

18. A wide pipe and a narrow pipe are connected together to form a long horizontal water pipe. Water is flowing at **3 m/s** in the wide section where the pressure is **$8.0 \times 10^5$ Pa**. As the water enters the narrower section its speed increases to **27 m/s**. The flow is steady, laminar, and nonviscous throughout the pipe and water has a density of **1000 kg/m$^3$**.

The pressure in the narrow region is:

A. $3.6 \times 10^5$ Pa
✓B. $4.4 \times 10^5$ Pa
C. $7.2 \times 10^5$ Pa
D. $8.0 \times 10^5$ Pa
E. $2.2 \times 10^6$ Pa

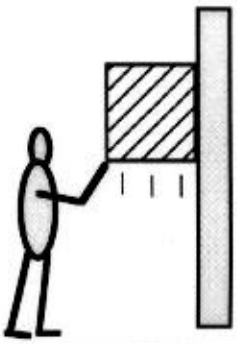
19. A **20-m**-long horizontal pipe is made by connecting a **10-m**-long section of pipe with an inside diameter of 5.0 cm to a second section, also **10-m** long, with a **15 cm** inside diameter. Water flows through the narrower section at **10 m/s** before entering the wider section where the pressure is **$8.0 \times 10^5$ Pa**. The flow is steady, laminar, and nonviscous throughout the pipe and water has a density of **1000 kg/m$^3$**.

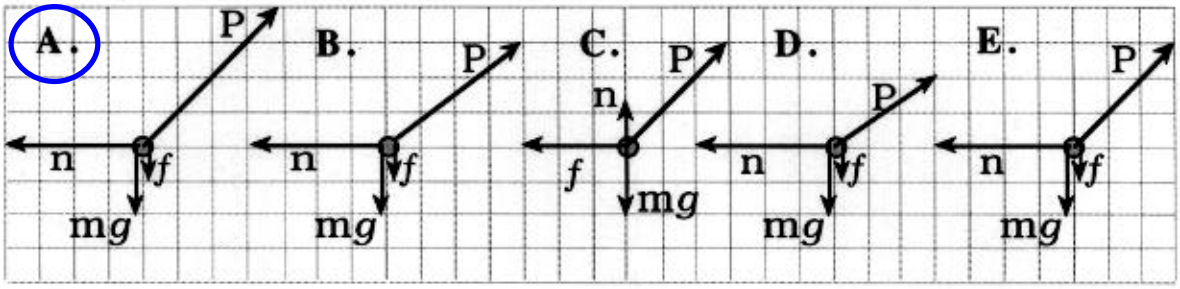
In the wider section the water flows at a speed of:

✓A. 1.1 m/s
B. 7.2 m/s
C. 12 m/s
D. 27 m/s
E. 56 m/s

20. You are pushing on a heavy box with a force **P**, causing it to slide up a vertical wall with *increasing* speed. The other three forces on the free-body diagrams below are the normal, frictional, and gravitational forces.

As shown, the weight force in all five free-body diagrams is *two* units long. The free-body diagram of the box that is representative of it sliding up the wall with *increasing speed* is:

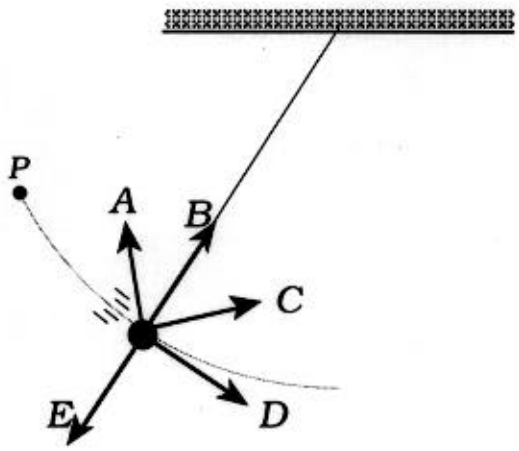





21. The acceleration of a car is *zero* when it is:

A. turning left at a constant speed.
✓B. traveling up a long straight incline at constant speed.
C. topping the crest of a hill.
D. bottoming out at the lowest point of a valley.
E. speeding up as it descends a long straight decline.

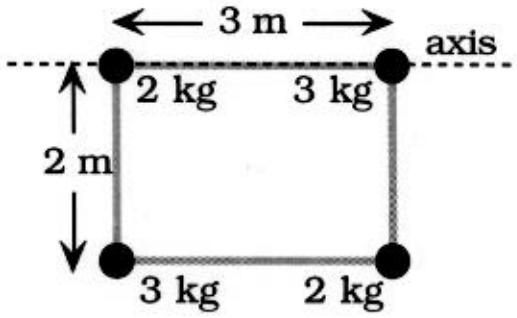
22. A small steel sphere is suspended from the ceiling by a light string. The sphere is released from rest at point *P* and descends along a circular arc as shown. During this descent the arrow best representing the *direction* of the *acceleration* of the sphere is:




A.
B.
C.
D.
E.

23. Four compact bodies are connected by rigid massless rods as shown.

The moment of inertia of the system about the axis shown is:




A. 6 kg•m$^2$
B. 10 kg•m$^2$
✓C. 20 kg•m$^2$
D. 26 kg•m$^2$
E. 47 kg•m$^2$

24. A **0.25 kg** body is suspended from a light spring (of negligible mass), stretching it **0.10 m** to a new equilibrium position. The body is then pulled down an additional **0.02 m** and released. The *period* of the resulting simple harmonic motion is:

✓A. 0.63 s
B. 0.71 s
C. 0.85 s
D. 1.04 s
E. 1.27 s

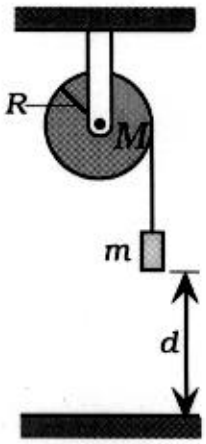
25. A body attached to a spring of force constant $k$ executes simple harmonic motion with amplitude A. Let E denote the total mechanical (kinetic plus potential) energy. At the instant the displacement is - A/2, the *kinetic energy* is:

A. - (1/2)E
B. (1/8)E
C. (3/8)E
D. (1/2)E
✓E. (3/4)E

26. A **0.25 kg** body moves in simple harmonic motion given by **x = (0.06 m) cos(12 t + 0.35)**, with **t** in seconds.
The *total mechanical energy* is:

✓A. 0.065 J
B. 0.13 J
C. 0.36 J
D. 0.72 J
E. 16.0 J

27. The pulley shown is a *uniform disk* with radius **R = 0.20 m**. and mass **M = 10 kg**. One end of a string is fastened to the perimeter of the pulley and then is wrapped around it several turns. A mass **m = 2.5 kg** is suspended from the other end of the string.




Released from rest, after falling a distance **d = 1.0 m** the speed of the mass is:

A. 1.22 m/s
✓B. 2.56 m/s
C. 3.53 m/s
D. 4.43 m/s
E. 6.29 m/s

28. Starting from rest, a wheel turns through **40 radians** in **4.0 s.** Assuming *constant* angular acceleration, its *angular velocity* at the end of the 4.0 s is:

A. 3.3 rad/s
B. 5.0 rad/s
C. 6.5 rad/s
✓D. 20 rad/s
E. 25 rad/s

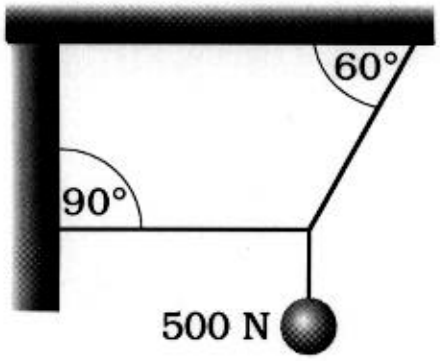
29. The speed of sound in air is **343 m/s**. The *lowest resonant frequency* (the fundamental) of an organ pipe **0.60 m** long, *closed* at one end and *open* at the other, is:

A. 113 Hz
✓B. 143 Hz
C. 189 Hz
D. 286 Hz
E. 567 Hz

30. On a day when the there is no wind a moving train sounds its whistle, which has a frequency of 500 Hz. The frequency heard by a stationary observer standing next to the track is 450 Hz. The speed of the train is: [Take $v_{sound}$ to be 343 m/s]

A. 34 m/s
✓B. 38 m/s
C. 45 m/s
D. 48 m/s
E. 98 m/s

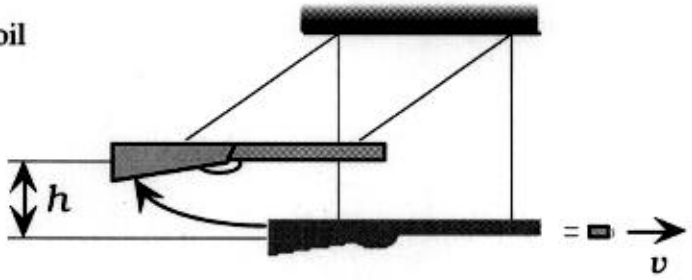
31. A body of weight **500 N** is suspended from a system of cords, as shown to the right.




The *tension* in the *horizontal* cord is:

A. 0 N
B. 146 N
✓C. 289 N
D. 354 N
E. 500 N

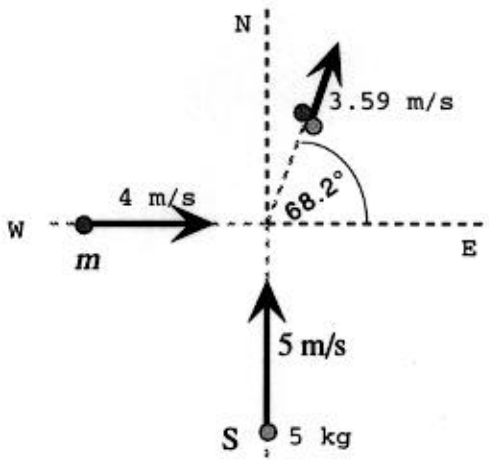
32. A **6.0-kg** rifle is suspended by two long strings as shown. The rifle is fired and the recoil results in the rifle swinging backward to a maximum height **h = 0.040 m**.




The speed of the **0.010-kg** bullet is:

A. 280 m/s
B. 400 m/s
✓C. 531 m/s
D. 720 m/s
E. 790 m/s

33. An object of mass ***m*** moving *east* at **4 m/s** collides with and sticks to a **5 kg** object that is moving *north* with a speed of **5 m/s**. After the collision, the velocity of the combined objects is **3.59 m/s** at an angle of **68.2°** *north of east*, i.e., **Az 021.8°**.




The mass *m* is:

A. -2.33 kg
✓B. +2.50 kg
C. +3.00 kg
D. +4.75 kg
E. +5.12 kg

34. The equation of a standing wave in a string is

$$y(x, t) = (0.004\ \text{m})\ \sin(30\ x)\ \cos(300\ t)$$

with x in meters and t in seconds. The maximum transverse velocity of a point on the string is:

A. 0.05 m / s

B. 1.2 m / s

C. 2.4 m / s

D. 20 m / s

E. 600 m / s

35. A string fixed at both ends is **3 m** long. It resonates with two antinodes at a frequency of **120 Hz**. The *speed* of transverse waves in the wires will be:

A. 30 m/s
B. 60 m/s
C. 180 m/s
D. 360 m/s
E. 540 m/s

36. The speed of a particle undergoing SHM is

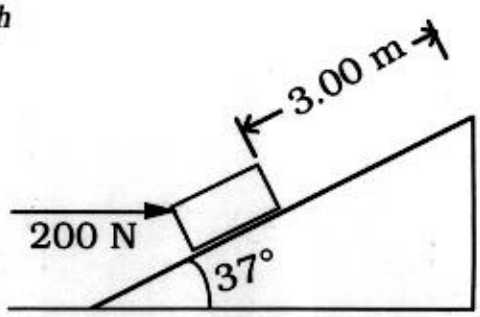
A. a *minimum* when the particle is passing through the equilibrium position.
B. *zero* when the particle is subject to the greatest force.
C. a *maximum* when the force is a maximum.
D. *constant.*
E. 180° out of phase with the displacement.

37. As a **2 kg** particle moves along the **x-axis** from **x = 1 m** to **x = 3 m**, the net work done *on* the particle is **20 J**. If the *speed* of the particle at **x = 1 m** is **5 m/s**, its *speed* as it passes the point **x = 3 m** is:

A. 2.24 m/s
B. 4.47 m/s
C. 5.92 m/s
D. 6.71 m/s
E. 9.47 m/s

38. A **24 kg** block is pushed **3 m** up the surface of a *rough* **37°** inclined plane by a *horizontal* force **F** of **200 N.**

The work done by **F** is:




A. 360 J
✓B. 480 J
C. 600 J
D. 705 J
E. 750 J

39. A **4.00 kg** block starts from rest and slides **5.00 m** down a plane inclined at **50°** to the horizontal. If the block has a speed of **4.30 m/s** at the bottom, the amount of mechanical energy *dissipated by friction* is:

A. 56 J
B. 98 J
✓C. 113 J
D. 133 J
E. 170 J

40. When a horse pulls a cart, the magnitude of the force exerted *on* the cart *by* the horse *exceeds* the magnitude of the force exerted *on* the horse *by* the cart:

A. if they are slowing down.
B. if they are speeding up.
C. if they are going downhill at constant speed.
D. if they are going uphill at constant speed.
✓E. under no circumstances.